InSAR Science Target Document

Purpose and scope

This document defines the target area of the InSAR mission and describes the method used to define those targets. It also includes some coverage figures derived from the current Baseline On-orbit Operations Memo as a base for further refinement of the targets by the science community.

Introduction

InSAR targets are divided between three types of physical phenomenon and one high priority area:

- Active seismic area
- Active volcanic area
- Glaciers
- Highest priority targets

The purpose of this division is to guarantee that the highest priority targets will be acquired at every opportunity while the remaining resources will be divided for the observation of the three types of surface deformation.

Target area organized by type

Seismicity

Source

http://neic.usgs.gov/neis/epic/epic_global.html
USGS/NEIC (PDE) 1973 – Present
351,000 earthquakes less than 70km deep
Significant Worldwide Earthquakes (2150 B.C. - 1994 A.D.)
1390 events

Processing

Events with offshore epicenters were discarded.
For this scenario, earthquakes that were more than 70 kilometers deep were ignored because they are not expected to produce a measurable signal on the surface.

The magnitude of all earthquakes recorded for each pixel of the map was summed and multiplied by 10. A threshold of 127 was used to convert this map to a mask.

In order to increase the readability of the attached map, the target area (white) has been increased by 5 pixels (~50km). This last step was not performed on the actual mask.

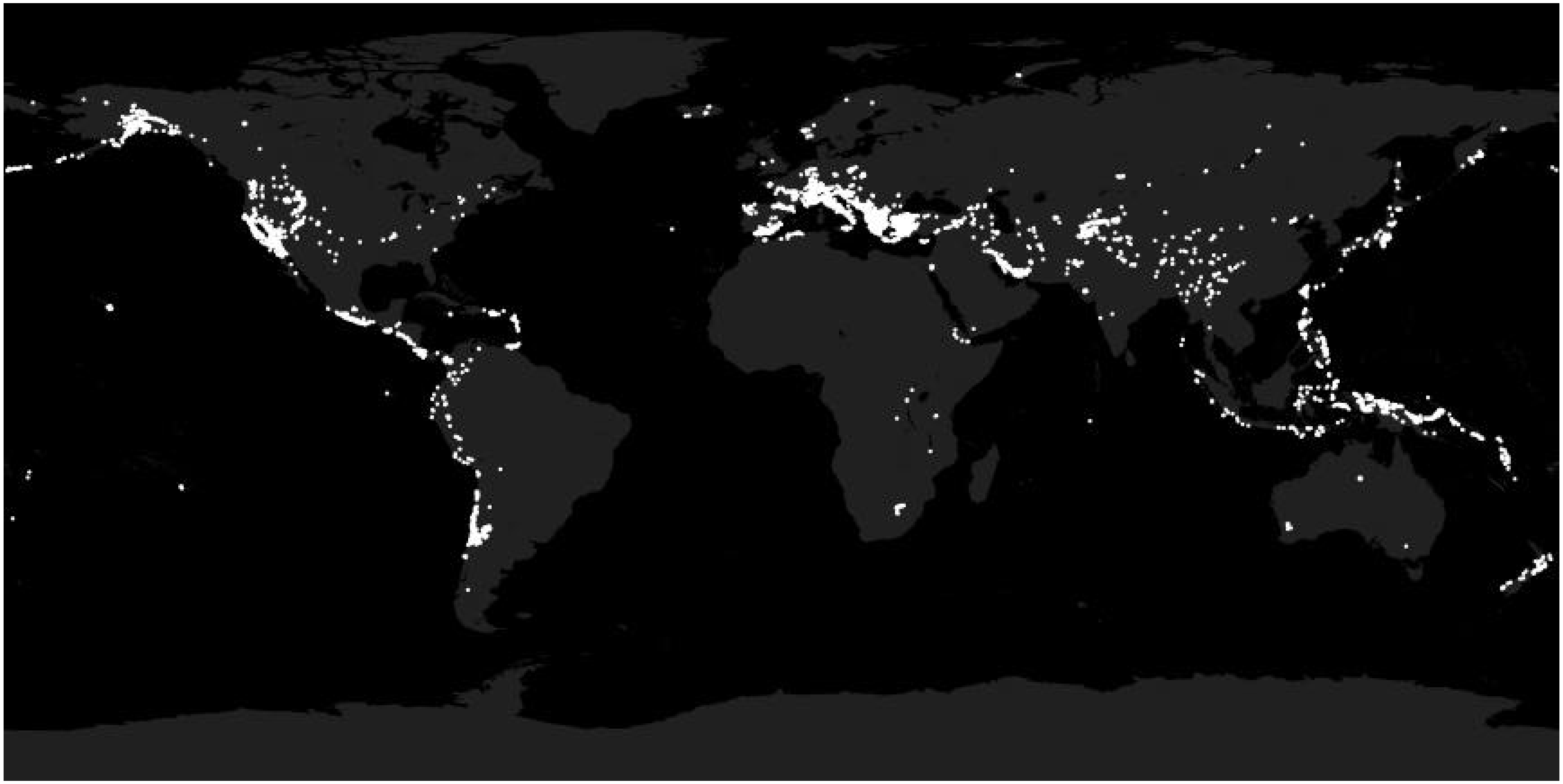
Mask Size

The area covered by all targeted pixels is 627,695 square kilometers.

Coverage

The baseline acquisition plan is to acquire any part of the mask 4 times (ascending/descending * right/left looking) every 48 days (8 days cycle x 6 beams to choose from).
This is implemented by selecting one beam for each ground track cycle and scheduling an acquisition any time a target is visible inside the active beam. At high latitude, some beams will never be turned on to avoid redundant coverage. This process is detailed later in this document.
Using this acquisition scenario for this mask results in an average of <u>3 minutes</u> of acquisition per orbit.

Figure 1. Seismicity – Active Seismic Areas



Volcanism

Source

http://www.ngdc.noaa.gov/seg/hazard/vol_srch.shtml
4400 events recorded since 79AD

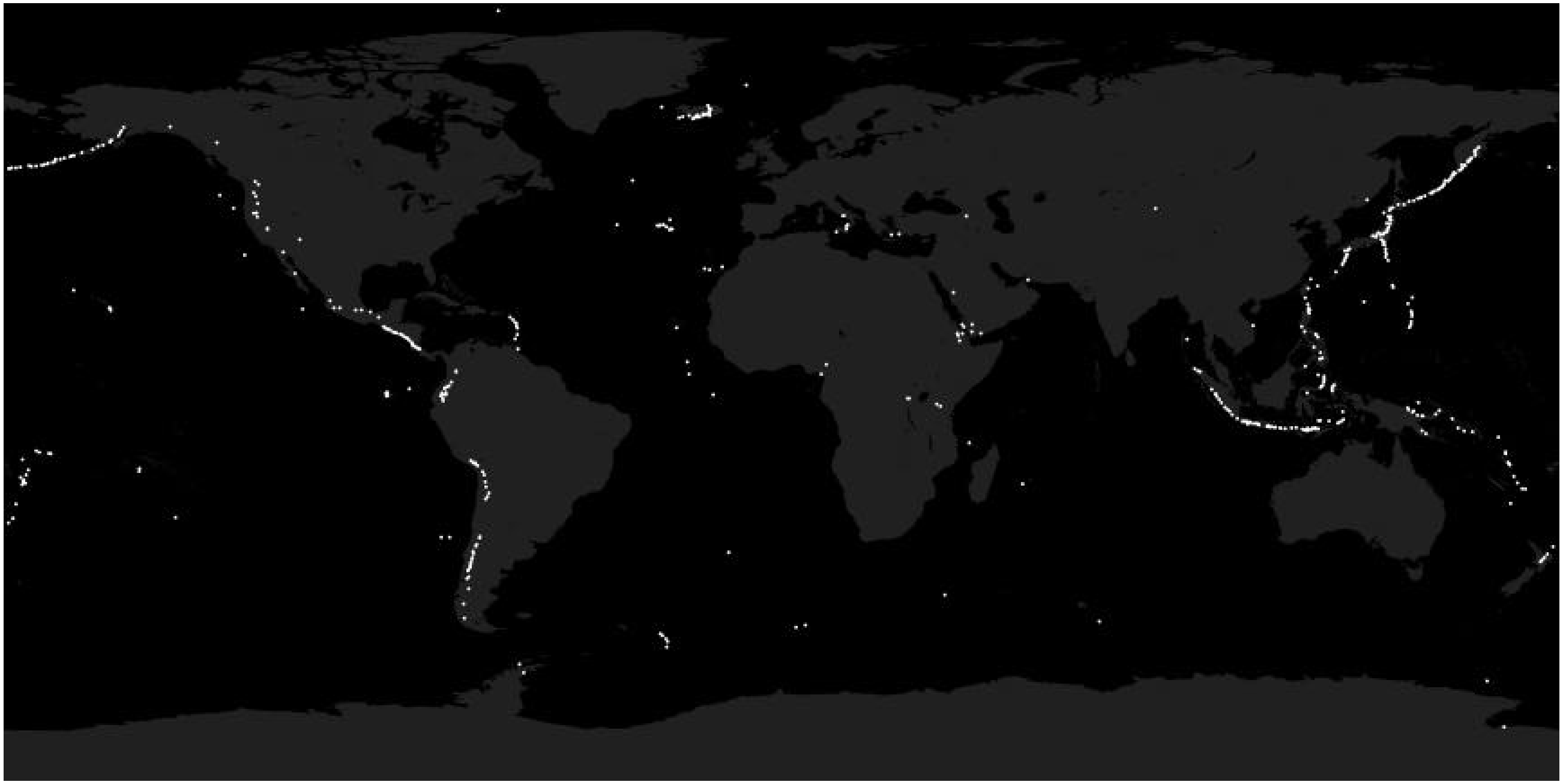
Mask Size

The area covered by all targeted pixels is 1,980,387 square kilometers.

Coverage

The baseline acquisition plan is to acquire any part of the mask 4 times (ascending/descending * right/left looking) every 48 days (8 days cycle x 6 beams to choose from).
This is implemented by selecting one beam for each ground track cycle and scheduling an acquisition any time a target is visible inside the active beam. At high latitude, some beams will never be turned on to avoid redundant coverage. This process is detailed later in this document.
Using this acquisition scenario for this mask results in an average of 2 minutes of acquisition per orbit.

Figure 2. Volcanism – Active Volcanic Areas



Cryosphere

Source

GLIMS glacier boundaries:
Bruce H. Raup, Hugh H. Kieffer, Trent M. Hare, and Jeffrey S. Kargel, “Generation of Data Acquisition Requests for the ASTER Satellite Instrument for Monitoring a Globally Distributed Target: Glaciers,” IEEE Transactions On Geoscience and Remote Sensing, vol. 38, no. 2, pp. 1105--1112, Mar. 2000.

Processing

The inland part of Antarctica did not show up after processing the GLIMS data. It was added manually.

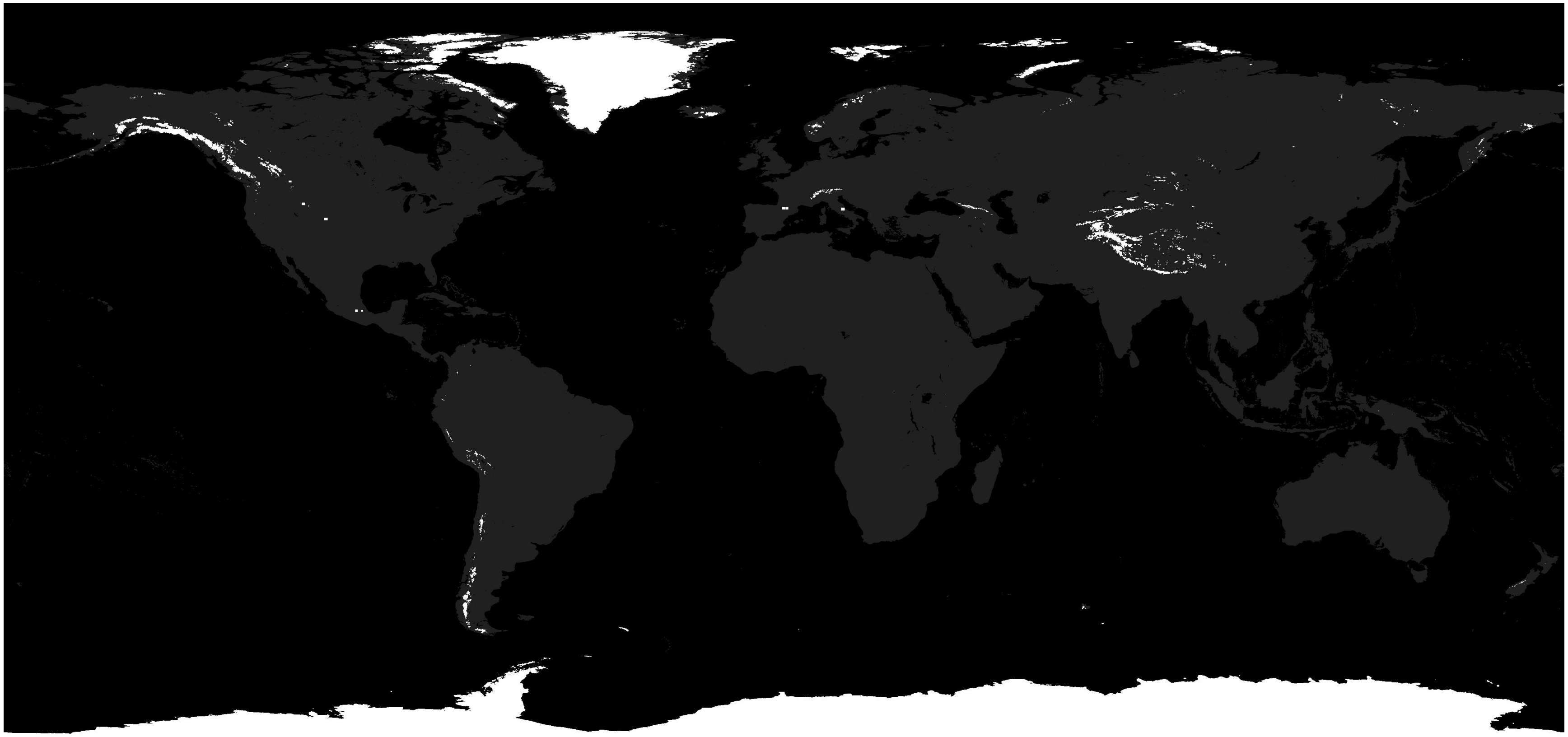
Mask Size

The area covered by all targeted pixels is 17,755,889 square kilometers.

Coverage

The baseline acquisition plan is to acquire any part of the mask 4 times (ascending/descending * right/left looking) every 48 days (8 days cycle x 6 beams to choose from).
This is implemented by selecting one beam for each ground track cycle and scheduling an acquisition any time a target is visible inside the active beam. At high latitude, some beams will never be turned on to avoid redundant coverage. This process is detailed later in this document.
There is a region around each pole that is not accessible. The maximum latitude is 87.3 degrees.
Using this acquisition scenario for this mask results in an average of <u>6 minutes</u> of acquisition per orbit.

Figure 3. Cryosphere – Glaciers



Highest Priority Targets

Source

At this time, this set of targets is made-up of the backbone GPS network as well as the cluster GPS location of the Plate Boundary Observatory (EarthScope).

Processing

In order to increase the readability of the attached map, the target area (white) has been increased by 5 pixels (~50km). This last step was not performed on the actual mask.

Mask Size

The area covered by all targeted pixels is 52,757 square kilometers.

Coverage

This set of targets is to be imaged at every opportunity.
This is implemented by selecting one beam for each ground track cycle and scheduling an acquisition any time a target is visible inside the active beam. If no target is present in the active beam, all other beams are searched.
Using this acquisition scenario for this mask results in an average of 1 minute of acquisition per orbit.

Figure 4. Highest Priority Targets – Plate Boundary Observatory

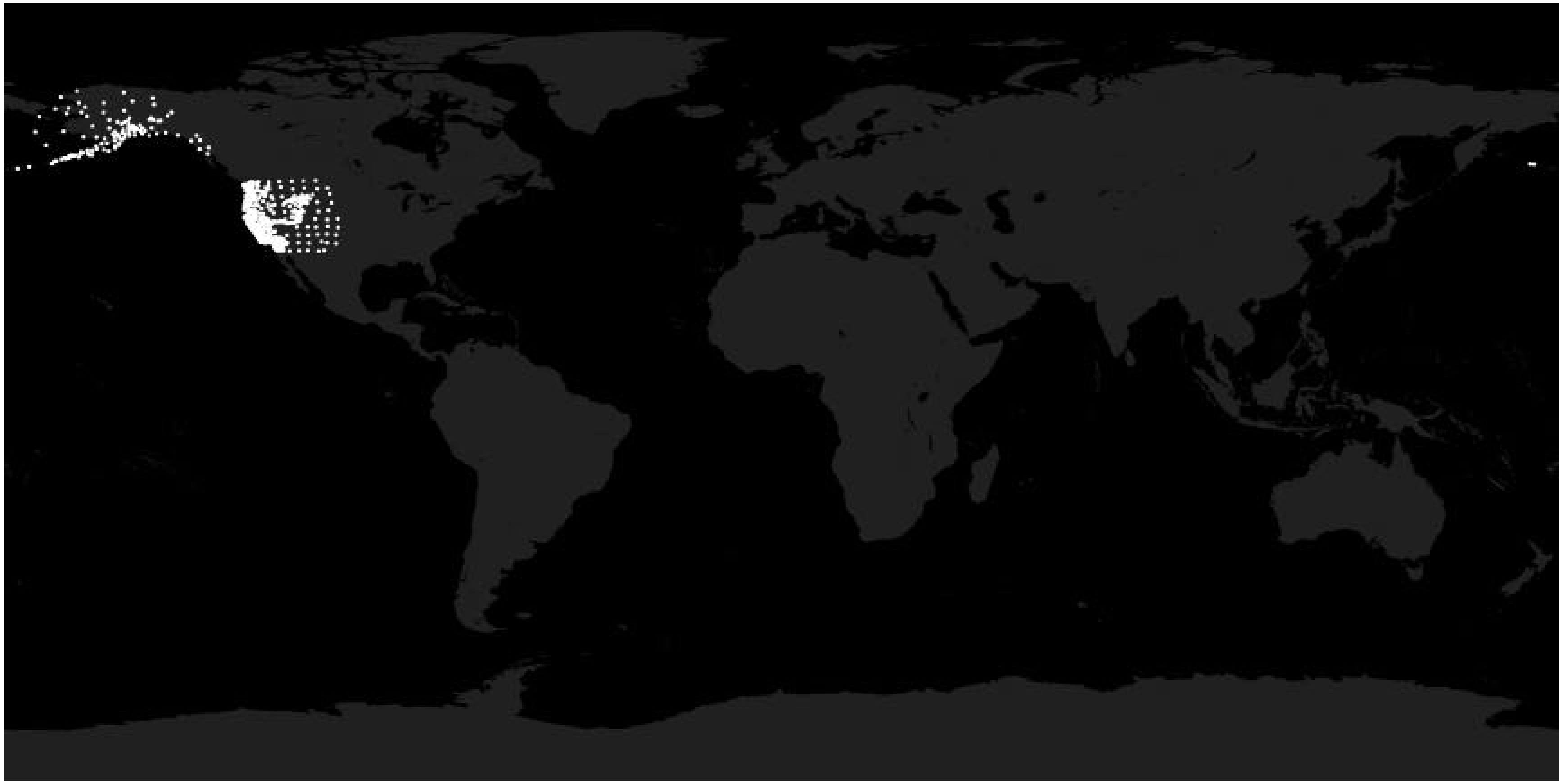
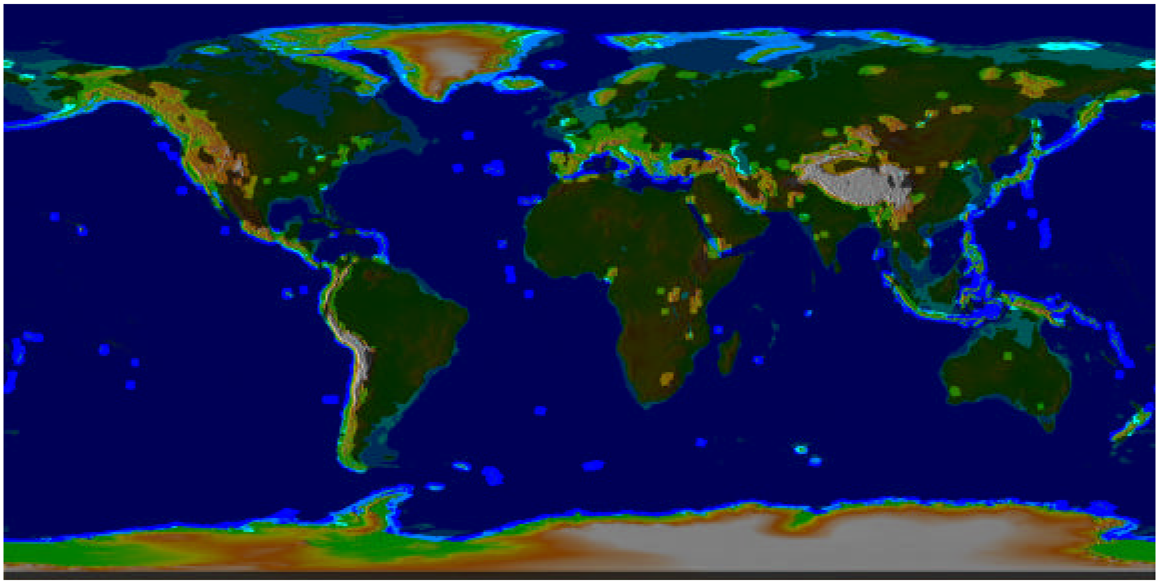


Figure 5. Sample coverage map using all the target masks defined above



Notes:
This map highlights the swaths that contain any target of interest. It includes 15 seconds padding at the beginning and end of each datatake.
This set of datatakes requires an average of 10 minutes per orbit.
This set of targets and acquisition rule meets the current on-time requirement and allows for a complete set of data to be acquired every 48 days.
Some earlier plans to acquire polar regions only during the local winter are not needed.

Details on how to limit redundant coverage at high latitude.

The number of orbit in the repeat cycle of the ground track as been chosen to provide a small amount of overlap at the equator between the outer beam of one obit and the inner beam of the adjacent orbit.
At higher latitude, the distance between adjacent ground tracks is reduced. The overlap increases, leading to redundant coverage.
In an effort to save resources, it is beneficial to stop using a given beam when similar data are available in a beam from an adjacent orbit.
The beams that are pointed closer to the pole are kept active longer in an effort to extend the coverage as close to the pole as possible.

The following table shows the latitude regions where each beam is active:

	Left 3	Left 2	Left 1	Right 1	Right 2	Right 3
65 to 90			x			x
45 to 65		x	x		x	x
-45 to 45	x	x	x	x	x	x
-65 to -45	x	x		x	x	
-90 to -65	x			x		

Time series analysis

The operating times listed for each target type are average minutes per orbit over a 48 days cycle. They were computed by going through the 6 beams sequentially (one 8 day groundtrack repeat per beam).

Using this rule to plan data acquisition would result in peak operating time of 30 minutes on some orbits.

For example, during the 8 day cycle were "Left 3" is active, the radar would operate continuously over Antarctica. When "Left 2" is active, the radar would be off when flying over both Polar Regions.

This imbalance could be reduced by several means:

- Cut long datatakes in segments and spread the data collection over the 3 8-days repeat cycle when the antenna is physically pointed the right way.
- Switching only between datatakes would have the less impact on data collection. However, it is not expected to help significantly in balancing the on-time between the 6 8-days cycles.
- Spreading the acquisition over the full 48 days repeat cycle would require the spacecraft attitude to be changed while flying over targets – not a good option.

Some generic scheduling tools are being developed by other projects. They would make it easier to select an operation scenario that would balance the use of resources (energy and data storage/downlink) with a minimum effect on the quality of the data.

Baseline map of all land

Acquiring a global set of data at the beginning of the mission would allow the creation of an interferogram in response to an event outside the targeted areas.

Using ScanSAR, the total on-time required to get 2 global maps (left and right looking) is 11,730 minutes.

This dataset could be acquired before the main data collection phase, or continuously by designing a system with more capabilities than required by the main data collection.

Assuming that the radar operates 10 minutes per orbit to create the baseline maps and that the on-time is equally spread between the 115 orbits of an 8-days cycle, it would take 80 days to complete the map. Using actual on-time per orbit would take 104 days to get the data from the busiest orbits with a 10 minute per orbit constraint.